Condensate Polisher Savings Of 23% Realized Through Value Engineering

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Summary

A well-known university, working closely with a knowledgeable water treatment equipment supplier and mechanical contractor, realized a capital cost savings of 23% on a condensate polisher project. These savings substantially improved the return on investment. This was accomplished without making any compromises on the installation costs, reliability of operation, or desired operating efficiency of the powerhouse. A value engineering team comprised of university personnel, the equipment manufacturer, and a mechanical contractor yielded the best system for the money.

Background

A university, plagued by numerous leaking heat exchangers in their steam distribution system, investigated the purchase and installation of a small sodium cycle condensate polisher for their powerhouse in 2007. In the face of a seemingly endless barrage of price increases for fuel and water treatment chemicals, the intent was to:

- Improve boiler water quality
- Minimize boiler blow down
- Enhance operating efficiency.

The university power plant operates an 1800 hp low-pressure water tube boiler plant. As long as anyone could remember, simply blowing down the boiler has been the solution to poor boiler water quality. The reality of fuel prices in the 21st century however, combined with a top down campus initiative to address the carbon footprint of the university, opened the door to consider a condensate polisher as a prudent purchase.

The university powerhouse generates 62,000 lbs/hr of steam with a maximum of 60% returning as condensate. The envisioned condensate polisher was accordingly sized for 75 gpm. Preliminary engineering estimates were obtained and in early 2008 the project development team established a budget to purchase and install a small condensate polisher in the university's powerhouse. The project was subsequently submitted for funding and was approved based upon the strength of the projected internal rate of return - calculated to be significantly higher than the university's cost of capital. Shortly thereafter the project was advertised for bid and everything was seemingly a go until the formal bids were received and reviewed.

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The Problems

All the qualified bids exceeded the set aside level of funding. During the time lag between project approval and initiation of the bidding process, a number of variables arose which collectively now jeopardized the project in its entirety. For starters, the cost of stainless steel, while recognized to be escalating, continued to climb beyond all reasonable expectations. Secondly, the university's internal cost of capital was adversely affected by a tightening of available funds within the credit market. Almost immediately, the university comptroller put the project on hold and demanded an even higher return on investment in order for the project to proceed. In an attempt to move the project forward, it was decided the university utility manager would work directly with the condensate polisher manufacturer and the winning bid mechanical contractor to see how best to value engineer the product offering. The targeted goal of the value engineering team was to reduce the purchase price of the condensate polisher by a minimum of twenty percent. This, together with some labor saving initiatives taken on by the mechanical contractor installing the system, would hopefully rescue the project.

Value Engineering Study Items

After a thorough review of the water treatment equipment by the value engineering team, the following items were found to be significant and worthy of further study:

1) How was the condensate polisher sized? What design parameters were employed?

2) Could the polisher be constructed in a material other than stainless steel?

3) Are there other suitable ion exchange resins that could be used?

4) Does the condensate polishing system's external piping need be stainless steel?

5) Could the control valves be constructed in something other than stainless steel?

Figure 1

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Figure 1

Initial Design of Condensate Polisher

Figure 1 is a photograph of a similar sized condensate polisher recently sold by the equipment manufacturer.

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Design Constraints

The review was conducted within the framework of the original motivating factors at the university. All agreed that no modifications to the scope of work would be entertained that negatively affected either the installation costs, reliability of operation, or the desired operating efficiency of the power house. While there were a few other areas of initial interest, beyond the five areas listed above, it was determined that their potential impact was insignificant when measured against the total system cost and associated target savings. Some of the items falling into this category included the brine system design and other miscellaneous but less expensive control instruments.

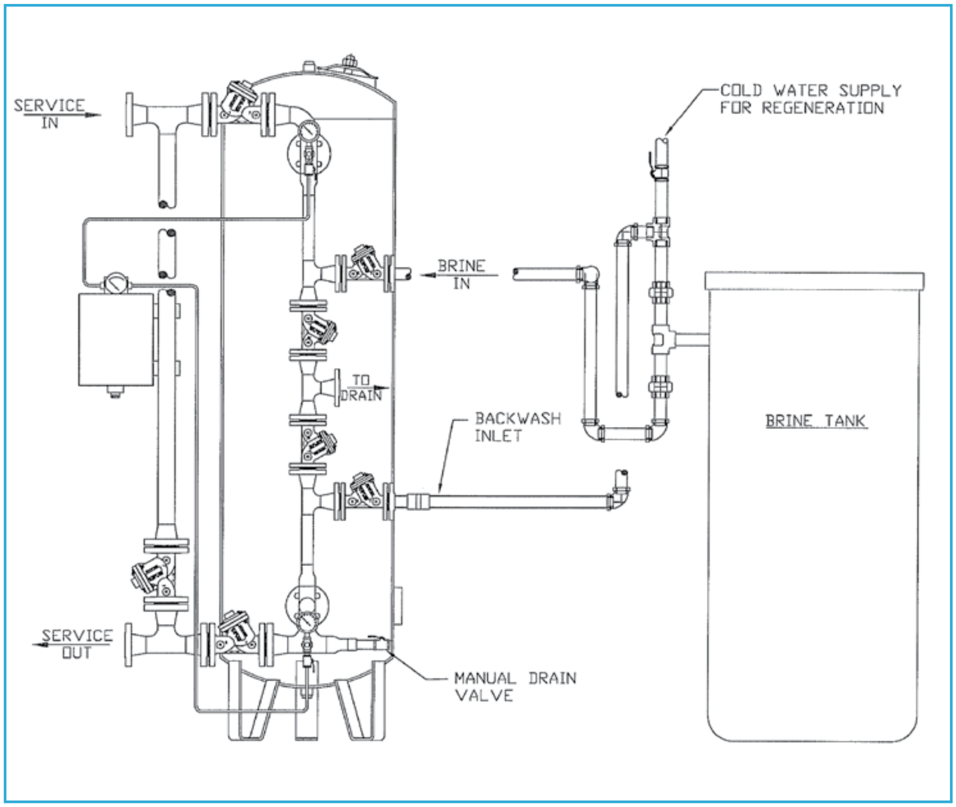

Figure 2

Results of the Value Engineering Team

It is the purpose of this paper to discuss the considerations of each study item in the context of current market costs, standard design parameters, and an experienced view of operating pitfalls that should be avoided regardless of any cost savings.

1) Sizing of the system

The condensate polisher was required to treat a design flow rate of 75 gpm. Specifications developed prior to bidding called for a 30" diameter vessel containing 15 ft^3 of condensate polishing

Figure 2

Drawing Of Condensate Polisher Under Consideration by the University (Note, in addition to the condensate polisher vessel, all the external piping is stainless steel as are the various control valves)

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resin. This would have put the design load at 15.3 gpm/ft^2 of ion exchange bed surface area.

With input from the equipment manufacturer, the value engineering team was informed condensate polishers are successfully operated at flows greater than 30 gpm/ft^2. The team determined that 25 gpm/ft^2 of ion exchange bed surface area was an acceptable design criteria– roughly equal to 1.6 times the previously quoted design criteria. The vessel would need a cross-sectional area of approximately 3 ft^2. Since pressure vessels come in standard sizes, the closest vessel size was 24" in diameter with a cross sectional area of 3.14 ft^2. The corresponding loading rate 23.8 gpm/ft^2 of ion exchange bed surface area was a more cost effective 95% of the acceptable design criteria. In addition to downsizing the vessel size to 24" diameter, the amount of condensate polishing resin required was reduced from 15 ft^3 to 10 ft^3.

The combination of these two changes would reduce the system purchase cost by 4% and was agreed to by the value engineering team.

2) Materials Of Construction For Condensate Polisher

Specifications developed prior to bidding called for the condensate polisher to be constructed of 304 stainless steel, rated for 100 PSIG, and carry an ASME code stamped certification. In view of the high price of stainless steel, the team decided to explore the possibility of having the condensate polisher constructed of carbon steel and equipped with a suitable high temperature liner. Ultimately, the team decided that stainless was a better choice despite its higher price.

Both the equipment manufacturer and the university utility manager had personally experienced the pitfalls of using carbon steel pressure vessels with a high temperature liner when the vessel diameters were smaller than 36 inches. High temperature linings applied to small pressure vessels are notoriously unreliable and often not even guaranteed by the liner installer. For the best, long-term performance, liner installers want to work inside the vessel during the lining process. With vessels smaller than 36 inches, many lining companies simply resort to spraying on the liner while working outside the vessel. This potential problem is further exacerbated if the liner should ultimately fail, as field repairs are near impossible given the limitations of field work taking place within the vessel.

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While it was agreed that lined carbon steel would be acceptable for a larger sized system, the decision was made in this instance to retain stainless steel vessels as a firm requirement for this project.

It was felt that ASME code stamped stainless steel vessels have an expected life well in excess of 20 years when used as intended.

Plus, it was pointed out that guarantees to this effect were obtainable from multiple tank shops experienced in fabricating stainless steel pressure vessels.

3) Choice Of Ion Exchange Resin

Specifications developed prior to bidding called for the use of Purolite C-150 cation resin or equal in the condensate polisher. This is a typical resin selection for sodium cycle condensate polishing applications. Purolite C150 is a macroporous polystyrene sulphonic acid cation-exchange resin with excellent resistance to osmotic and thermal shock. Its sponge-like, highly cross-linked structure permits higher rates of diffusion of most cations including those of heavy metals. It also is well suited for positively charged organics of higher molecular weight, and facilitates their removal on regeneration. These properties of physical robustness, good regenerability, and fast exchange kinetics make it ideal for condensate polishing applications.

However, along with other macroporous resins, the Purolite C150 is approximately twice as expensive as gel type cation resins which are sometimes used in high temperature water softening applications. The Purolite gel cation resin used for condensate polishing is C-100 x10. Given the price premium per cubic foot, the value engineering team looked at the potential cost savings associated with using a gel type resin such as C-100 x10 versus the macroporous type cation resin C150.

Mindful of the less rugged structure of a gel resin, the team decided to stay with C-150 as originally specified. This seemed especially prudent in view of a resin requirement of only 10 ft^3.

4) External Piping Materials Of Construction

The original condensate polisher specification called for the external piping to be sympathetic to the pressure vessel and be constructed of stainless steel. Furthermore, given the problematic nature of leak prone threaded stainless steel, the piping had to be of flanged and welded design. The university utility manager observed that none of the supply or discharge piping either coming to or leaving from the intended condensate polisher would

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be stainless. This then begged the obvious question of why the valve nest external piping had to be fabricated using flanged and welded stainless steel. With no valid answer to this question, the cost savings were calculated based on threaded galvanized piping being substituted for flanged and welded stainless.

This savings turned out to be significant, amounting to approximately 13% of the total purchase price for the system.

It also quickly moved the team's attention towards the last area of potential savings on their list.

5) Control Valve Materials Of Construction

As originally specified, the system control valves were to be a flanged stainless steel diaphragm type as manufactured by GE/Aquamatic. In that a GE/Aquamatic electronic controller was also specified, the projected system operation was envisioned to be simple and straightforward. It was the goal of the value engineering team to retain this simplicity while reducing costs through more cost effective materials of construction.

After eliminating the requirement for stainless steel in the external piping valve nest, it became somewhat obvious that the control valves no longer needed to be stainless steel, nor did they need to be flanged.

A total of seven control valves made up the system, and by switching Aquamatic high temperature threaded cast iron diaphragm valves for flanged stainless steel Aquamatic valves, the price to purchase the water treatment equipment was reduced another 6%.

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Summary of Review Items and Associated Savings

As shown in the following summary, the benefits of joining together a team of knowledgeable and experienced individuals can be readily apparent. This is particularly true when the individuals come to the task with complementary but differing skill sets combined with a shared sense of purpose.

Value Engineering Study Items	Installed System Savings
Downsize Vessel Size	4%
Retain stainless steel vessel	–
Retain C-150 resin	–
Modify external piping	13%
Modify control valves	6%
Total Value Engineering Savings	23%

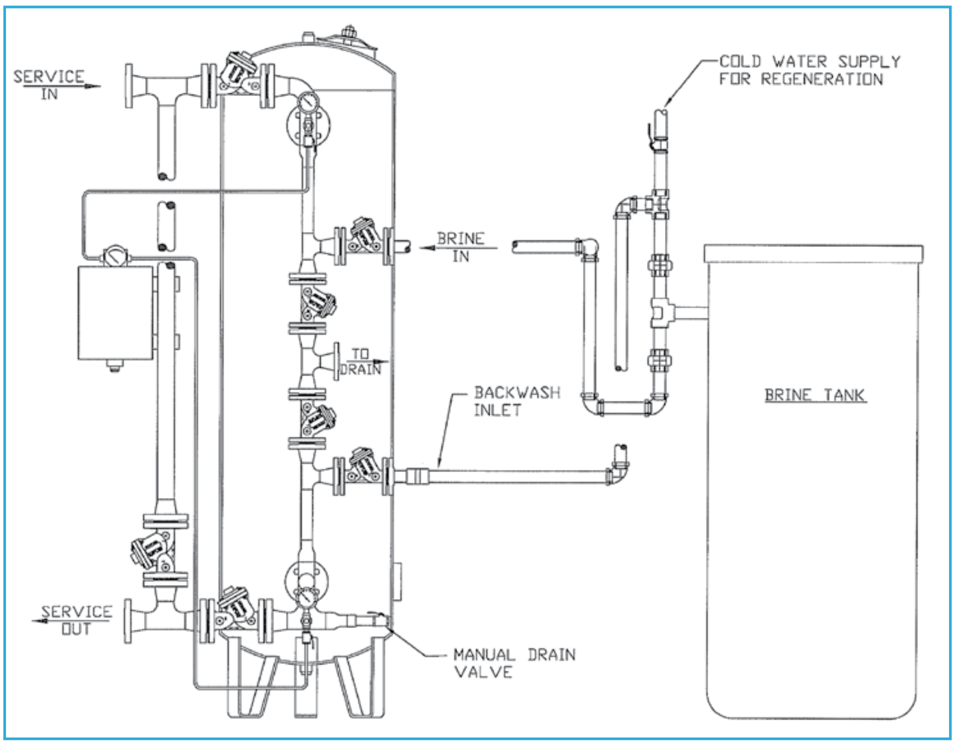

Figure 3

Figure 3

Drawing Of Value Engineered Condensate Polisher

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